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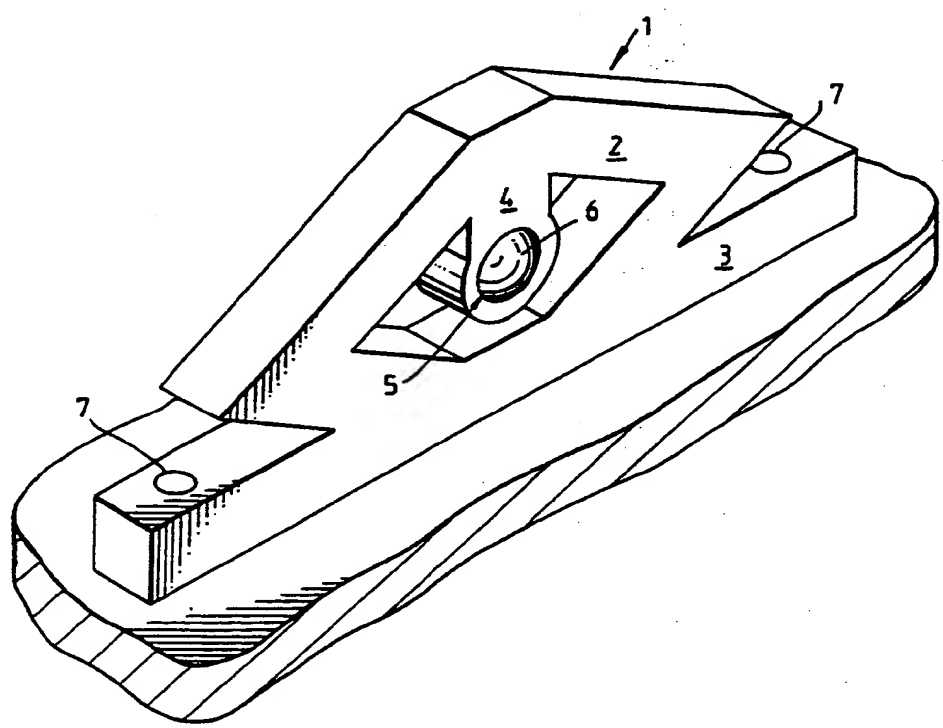

(57) Abstract

A lens mount (1) for a miniature optical lens (6) comprises a frame (2, 3) capable of plastic deformation in and parallel to its major plane (U-D & L-R). Movement out of the plane (B-F) may also be provided for. This arrangement allows minor re-adjustments to optical lens alignment to be performed after assembly.

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MOUNTING OPTICAL COMPONENTS

This invention relates to optical components and optical component mounts. The invention finds an important application in mounting miniature lenses in optical devices of the kind used for optical communications technology.

Taking as an example an optical fibre communications system, many of the devices used in such a system transmit light between their components in the form of a light beam travelling through free space. The distance over which the light travels as a beam is typically a few micrometres, but may be up to several millimetres and more.

Whatever the distance, accurate and stable alignment between the starting and finishing points of the beam is an obvious necessity if coupling losses are to be kept low. Often, the beam will pass through a lens which is provided to relax particular alignment constraints. In a transmitter, the lens will typically focus the light output of a light source such as a laser, for example, onto the end of an optical fibre; in a receiver, the light emerging from a fibre end may be collimated by a lens to be incident on a photodetector such as a PIN photodiode, for example.

An optical transmitter in which light emerging from a laser is focused by a spherical lens onto the end of an optical fibre is described in published international patent application WO88/10018 ("Optical Devices", BT&D Technologies Ltd.).

The previously mentioned need for good optical alignment constitutes one of the recurrent problems in the manufacture of optical devices for use in optical communications systems and the like. Adequate alignment present difficult problems owing to the smallness of the components themselves; the high accuracy required of the alignment, typically just a few micrometres or less; and to the need to ensure that alignment will remain stable for the device lifetime of 25 years or more.

The present invention is concerned with providing a mounting arrangement for optical devices that provides good long term alignment at a relatively low manufacturing cost.

According to a first aspect of the present invention, a mounting arrangement for optical components comprises a support member capable of plastic deformation in and parallel to its major plane, the support member being provided with means to mount one or more optical components thereon.

According to a second aspect of the present invention, a mounting arrangement for miniature optical lenses comprises a support member capable of plastic deformation in and parallel to its major plane, the support member being provided with means to mount one or more optical components thereon.

Preferably the support member is plastically deformable also in a direction normal to said major plane.

According to a third aspect of the present invention, a lens mount for a miniature optical lens comprises a support member capable of plastic deformation in and parallel to its major plane. Movement out of the plane may also be provided for.

The support member according to the present invention preferably comprises a frame structure.

The frame structure defines an essentially enclosed space with mounting locations for optical components being conveniently located within this space. For example, the frame structure may be provided with an optical component mount projecting into the interior of the space defined by the frame structure. If desired, mounting locations for optical components may instead, or additionally, be provided on the exterior of the frame structure.

The frame structure may be open towards its associated base; that is to say, an essentially enclosed space is defined only once the frame

structure has been mounted on its base. Such an open frame structure often enables the mounted optical components to be closer to the base than would be the case for a corresponding closed frame structure.

The support member may comprise two or more relatively rigid portions which are linked by relatively deformable portions. Instead, however, the support member may be of similar deformability substantially throughout.

Where the support member is of a frame structure having corners, the corners may provide deformable zones.

The material which forms the deformable portions of the support member needs to have low resilience so that the shape imposed by an adjustment is retained.

The afore-described arrangements according to the present invention allow adjustments, such as re-alignment of optical lenses, for example, to be performed after assembly.

The present invention will now be described further by way of example only with reference to the accompanying drawings, of which:-

Figure 1 is a perspective schematic view of a lens mount in accordance with the present invention, with Figure 1a illustrating the adjustability of the lens mount of Figure 1;

Figure 2 shows a schematic view of an optical device assembly comprising a plurality of optical components;

Figures 3a to 3c and Figure 4 are schematic front views of embodiments illustrating various modifications over Figure 1;

Figures 5 is a sectional view taken along line V-V of Figure 3a;

Figure 6 illustrates a practical arrangement for supplying lens mounts attached to a feeder strip; and

Figure 7 illustrates further modifications of the present invention.

Referring now also to the figures, Figure 1 shows a lens mount 1 comprising an approximately diamond shaped frame portion 2 and integral therewith a straight foot section 3. Projecting into the interior of the frame from its corner opposite the foot section 3 is a lug 4. The lug 4 has an aperture 5 which makes a press fit with a lens 6.

As illustrated in Figures 3a to 3c, for example, the aperture 5 may be of any suitable shape which makes a push fit with the lens 6. The lens 6 is a spherical lens, although other forms of lens may be used such as, for example, a graded index rod lens (not shown).

Figure 1a is a schematic presentation of the manner in which the frame 1 of Figure 1 can be adjusted to position the lens 6 of Figure 1 in the appropriate position. As illustrated by the arrows, the lens can be moved up or down (U<-->D), left and right (L<-->R) and forwards and backwards (F<-->B). In general, most practically performed adjustments will be made up of a combination of movements in two or, possibly, all three directions described here. It should be noted that the up-down movement and left-right movement lie generally within the plane defined by the frame, while the front-back movement is arc-like in a direction approximately normal to that plane.

To adjust the position of the lens 6, the frame 1 is deformed by applying an external force by means of a suitable tool (not shown). The deformation of the frame 1 may occur, essentially, in one of two ways: either the frame as a whole distorts, or distortion is restricted to dedicated portions of the frame, such as the hinge points indicated by empty circles in Figure 1a. Such hinge points may be points of lower material strength, for example, or be regions of high stress concentration under an applied load. Since self-deformation under operating conditions is clearly undesirable, the material strength of the frame needs accordingly to be chosen such that deformation requires the application of a tool.

Figure 2 shows the lens mount 1 mounted on a block 12 together with a light source 13 and an optical fibre 11. The frame 1 and the block 12 are mounted on an intermediate base 10. The frame 1 is affixed to the block 12 by means of two spaced spot welds 7. In order to enable spot welds to be made, the foot section 3 of the frame 1 extends beyond the corners of the frame 1 itself. Brazing, soldering or organic adhesives may replace the spot welds in appropriate circumstances.

The procedure to align the light source 13, the optical fibre 11 and the lens 6 in the lens mount 1 is, essentially, a trial and error method. Thus, affixing a lens mount 1 proceeds as follows:- The light source 13 is switched on and the lens mount 1 is positioned to achieve the desired alignment between it, the source 13, and the fibre 11. In this position, the lens mount 1 is attached to the block 12, in the manner described above. The procedure of affixing the lens mount 1 on the block 12 will tend to disturb the previously achieved alignment, especially so in the case of spot welding. Any such misalignment occurring during that procedure is then corrected, with the light source 13 still under power, by deforming the lens mount 1 with a suitable tool (not shown) until the desired optical alignment is obtained. The necessary degree of accuracy in obtaining alignment and hence the exact procedure for obtaining it will largely depend on the particular application. A greater degree of alignment accuracy will normally be required for a single mode fibre than for a multimode fibre, for example.

Figures 3a to 3c show three different embodiments of the approximately diamond shaped frame of Figure 1. The frame of Figure 3a is substantially identical with that of Figure 1, save that its lens is push-fit mounted in a hexagonal aperture 35.

The frame of Figure 3b differs from that of Figure 3a primarily in that the centre section of the foot section 3 has been removed, leaving two side portions 33 of the foot section 3. This enables the lug 4 depending from the top of the frame to be longer than in Figure 1 which, in turn, enables the lens to be mounted in a lower position relative to the foot section 3 than would be possible with the frame of Figure 3a.

The frame of Figure 3c has a short foot section 38 which would be used in situations where the frame is to be affixed to the front rather than the top of the base 10 of Figure 2. In addition Figure 3c illustrates an approximately square aperture, with rounded corners, where the lens is held in place by the four straight sides of the aperture.

The individual characteristics of the three examples 3a to 3c can obviously be combined in various ways to form frames of the kind shown in Figure 1.

Another embodiment of the invention is shown in Figure 4. The frame shown in Figure 4 is, essentially, an inverted T shape in which the aperture 5 for mounting the lens is located at the far end of the stem 42 of the T, and in which the foot section 43 is formed by the crossbar of the T. Nearest the crossbar, the stem 42 is weakened by two offset slots 47 and 48, to form the bridge 44 which is a zone of mechanical weakness. As will be readily appreciated, slot 47 and 48 permit left to right movement by bending deformation of the bridge 44. Up and down movement of the portion 42 causes shear deformation of the bridge 44, while movement to the back and the front causes a torsional deformation of the bridge 44. Additional zones of weakness may be provided, e.g. with the aid of additional slots (not shown), to obtain a greater range of adjustability.

Figure 5 is a section along the line V-V of Figure 3a and illustrates in greater detail the position of the lens 6 within the frame 1. As shown, the lens 6 makes a push fit with the sides of the aperture 35 in the lug 4.

In order to reduce unwanted reflections, the lens 6 is provided with an anti-reflection coating 67. The anti-reflection coating 67 is preferably applied to the lens only after the lens has been inserted into the frame 1. Indeed, it is one of the advantages of using a frame such as that provided by the present invention, that the frame 1 can be used as a convenient clamp for holding the lens 6 during anti-reflection coating and, of course, thereafter.

Referring now specifically to Figure 6, the frames, shown here with lenses 66 inserted, are conveniently formed along a strip 67 and attached to the strip along a break line 68.

In use, lenses are inserted into the apertures of frames 61 and are then anti-reflection coated. Subsequently each frame 61 is snapped off the strip 67 along the break line 68, and attached to a base such as base block 10 in Figure 2.

A further modified form of the present invention is shown in Figure 7. The frame shown there is modified to permit mounting thereon an assembly of a photodiode and a lens , such as is described, for example, in published international patent application WO89/05467 ("Light Sources", BT&D Technologies Ltd).

The frame 71 Figure 7 is an open frame having a central section 76 depending on each end via a strip 74 from a support arm 72, 73, whereby the outer ends of the support arm provide the foot section 73 for securing the frame 71 to a base (not shown) such as base 10 of Figure 2.

The material of the frame is preferably chosen to closely match the expansion coefficient of the base to which the frame is to be secured. Often the base will form the heat sink for an active device such as a laser or light emitting diode. If the base is a diamond heat sink the frame is preferably made of Invar™. If the base is copper, the material for the frame may be nickel; and in the case of a silicon base, Kovar™ is a material with a suitably matched expansion coefficient.

Depending on the required size and the material of the frame, the frame can be formed by methods such as mechanical stamping, photo etching, machining, spark erosion, or laser cutting. The aperture for accommodating the lens can be similarly formed.

In all the afore-described cases the material thickness, stiffness, deformability and other material parameters are chosen, for a given design of frame, such that in use the frame resists deformation even when subject to moderate shocks, while being sufficiently pliable to be deformed with

the aid of an adjustment tool. Where the frame is designed to have clearly defined deformation zones, the dimensions etc. of its deformable zones will be chosen accordingly.

CLAIMS

1. A mounting arrangement for optical components comprising a support member capable of plastic deformation in and parallel to its major plane, the support member being provided with means to mount thereon one or more optical components.

2 A mounting arrangement for miniature optical lenses comprises a support member capable of plastic deformation in and parallel to its major plane, the support member being provided with means to mount thereon one or more optical lenses.

3. An arrangement according to claim 1 or claim 2, wherein the support member is plastically deformable also in a direction normal to said major plane.

4. An arrangement according to any preceding claim, wherein the support member comprises two or more relatively rigid portions which are linked by relatively deformable portions.

5. An arrangement according to any of claims 1 to 5, wherein the support member is of similar deformability substantially throughout.

6. An arrangement according to any preceding claim, wherein the support member comprises a frame structure.

7. An arrangement according to any preceding claim, wherein the support member comprises a frame structure provided with an optical component mount projecting into the interior of the space defined by the frame structure.

8. An arrangement as claimed in any preceding claim 7, wherein the the frame structure is open on the side designed to face its associated base.

9. A lens mounting arrangement for a miniature optical lens as claimed in any preceding claim.

10. An optical component including a mounting arrangement as claimed in any preceding claim.

Fig.1

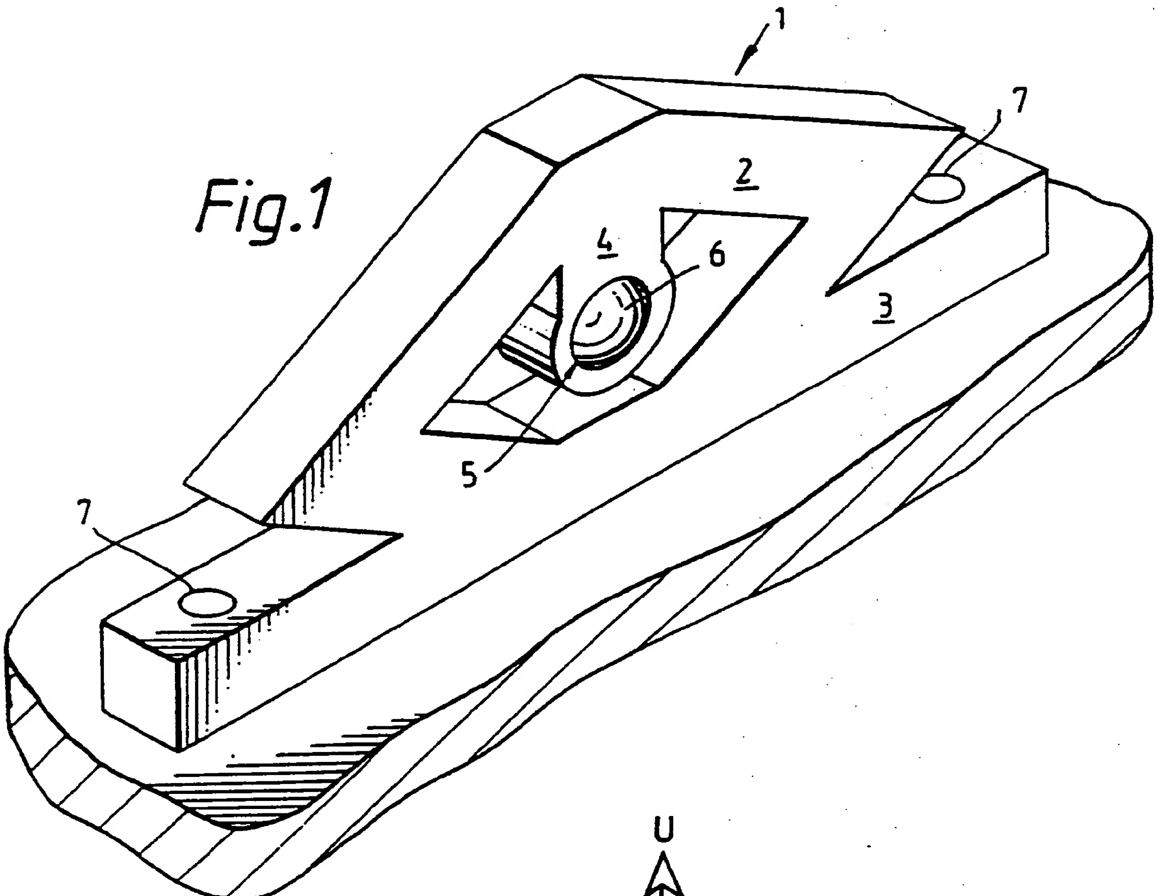


Fig.1a

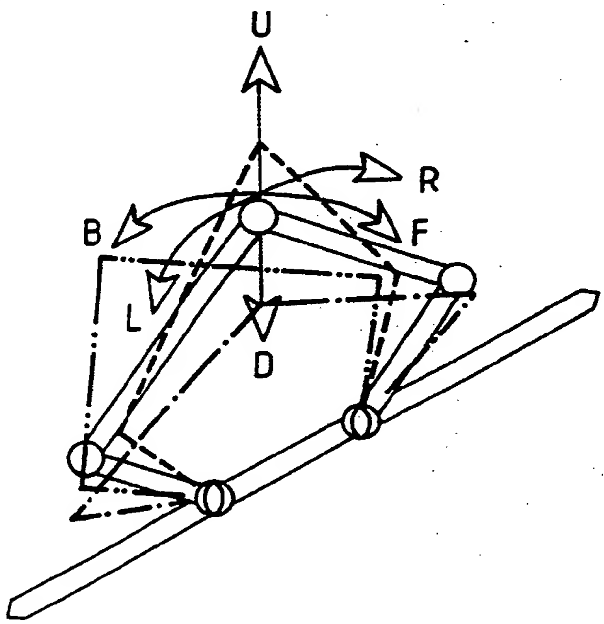


Fig. 2

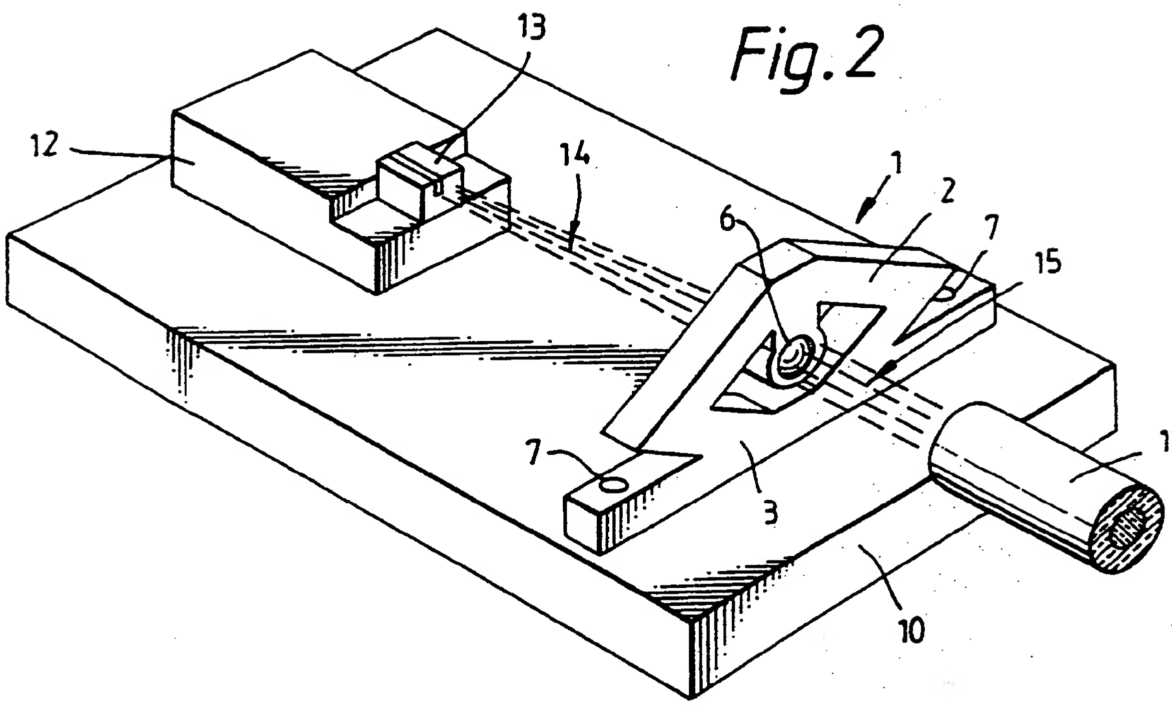


Fig. 4

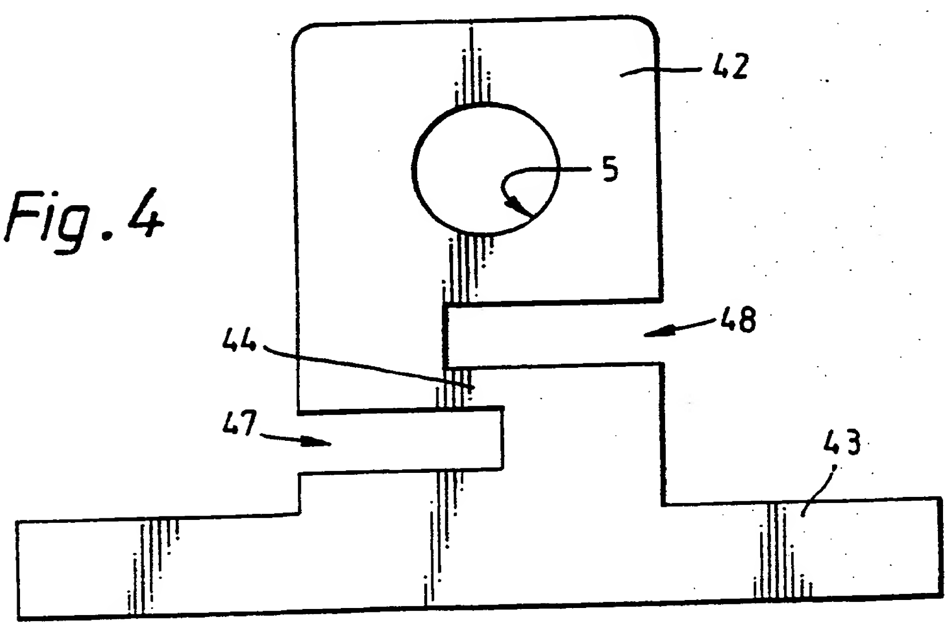


Fig. 3a

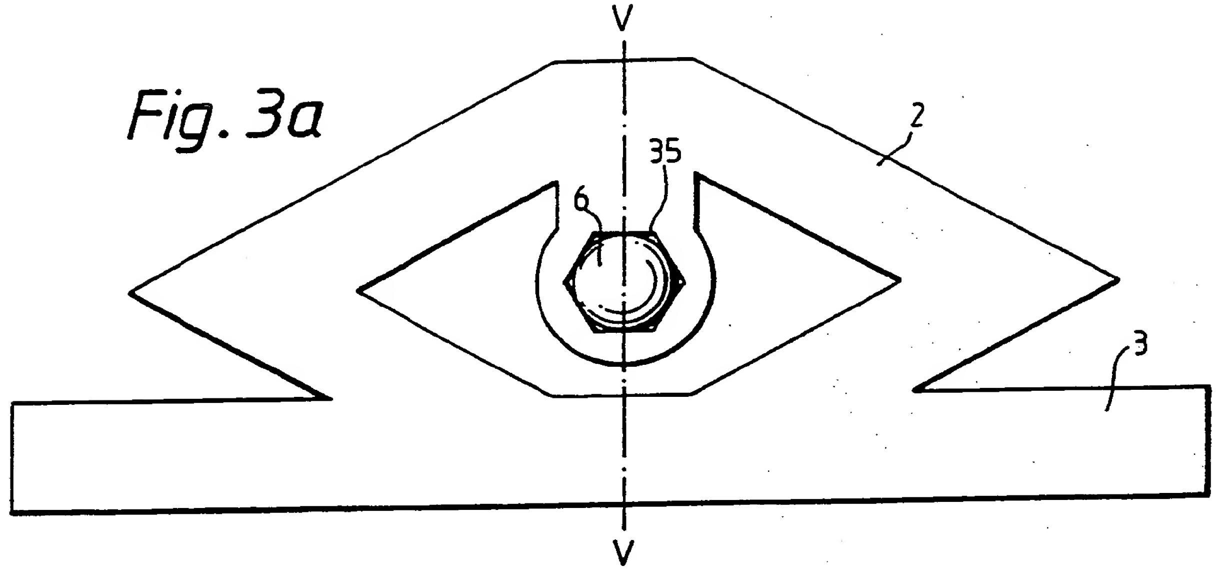


Fig. 3b

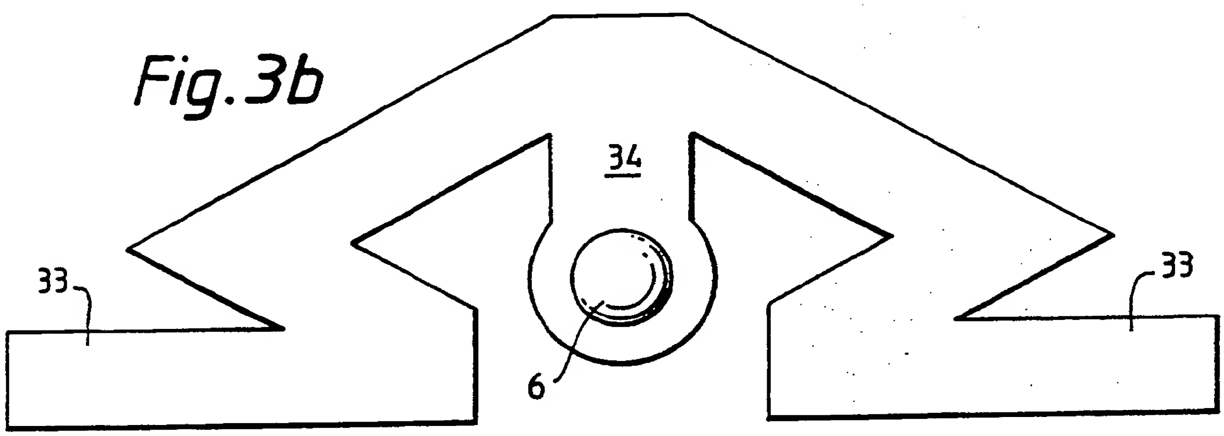
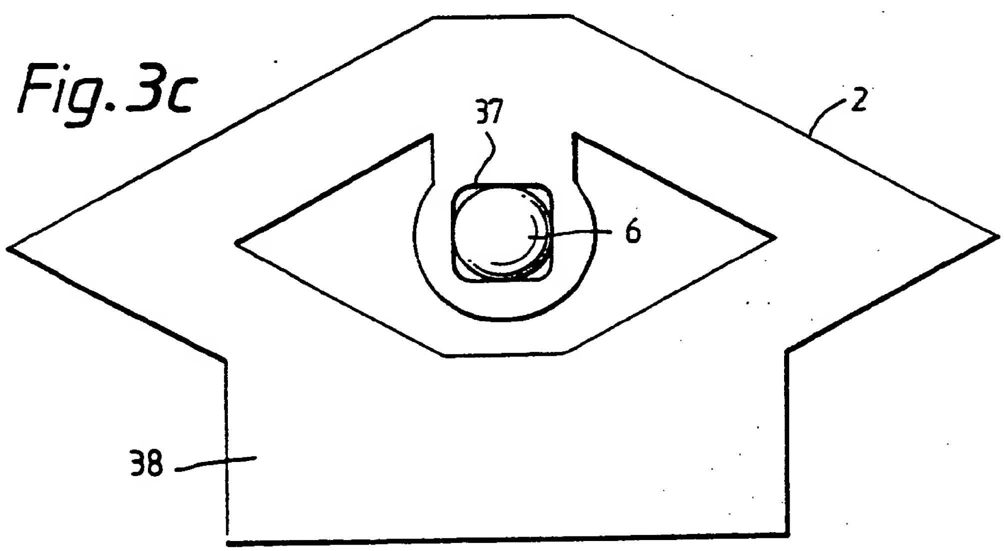


Fig. 3c



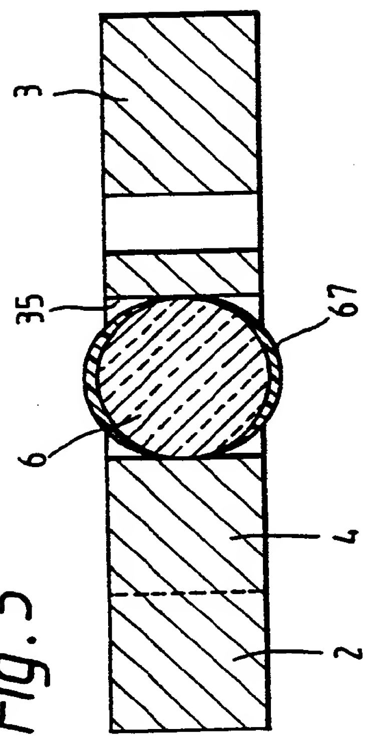


Fig. 5

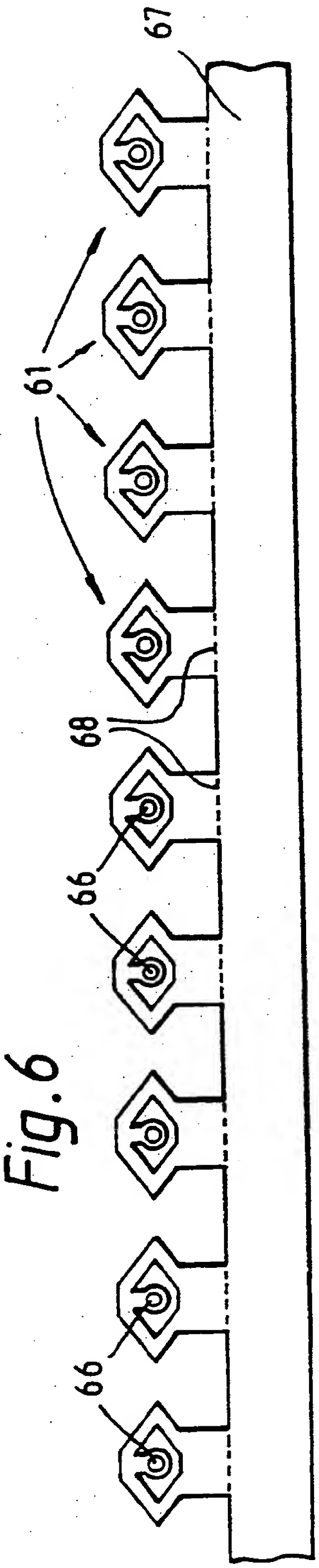


Fig. 6

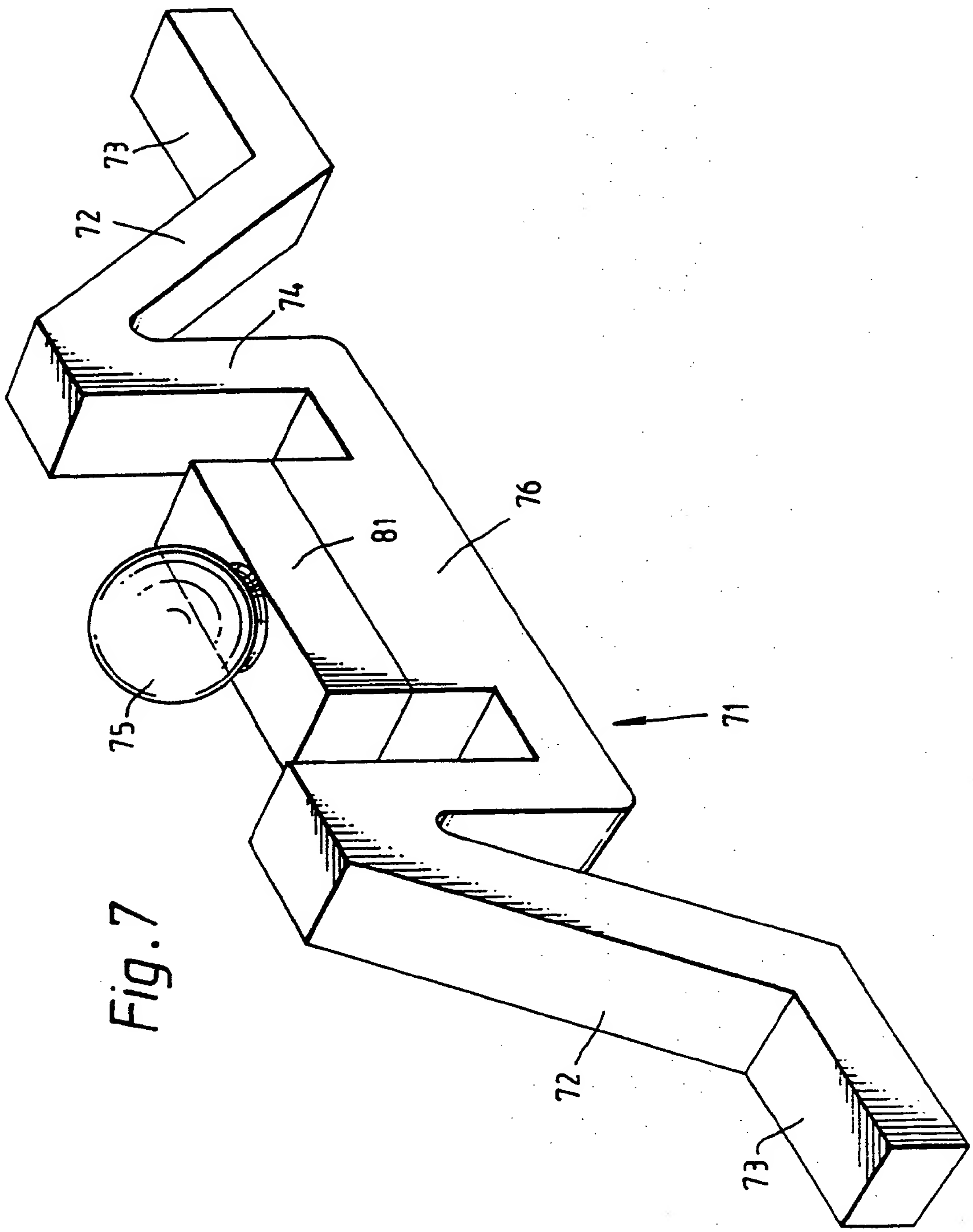


Fig.7

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/01583

I. CLASSIFICATION F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^5: G 02 B 6/36, G 02 B 7/02, G 02 B 6/42, F 16 C 11/12

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^5	G 02 B 6/00, G 02 B 7/00, F 16 C 11/00, B 25 J 7/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	EP, A, 0269925 (COMPAGNIE LYONNAISE) 8 June 1988 see figures 1-5; page 3, lines 14-58; page 4, lines 1-2; claims	1,2
A		5,6
	--	
Y	US, A, 4793688 (K. AIKI et al.) 27 December 1988 see figures 2,3,5,7,8; column 4, lines 5-39; column 7, lines 50-68	1,2
A		3,9,10
	--	
A	EP, A, 0168820 (SIEMENS) 22 January 1986 see the whole document	1,3,5,6
	--	
A	EP, A, 0193991 (STAAT DER NEDERLANDEN) 10 September 1986 see figures 4,5; page 14, lines 3-31; page 15, lines 1-3	1,5,6
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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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EUROPEAN PATENT OFFICE	Miss T. TAZELAAR